

# Compact, Low Current Superconductor Coil Operating Above 15 K for Magnetic Cooling, Phase I

Completed Technology Project (2018 - 2019)



## Project Introduction

Adiabatic Magnetic Refrigeration (ADR) can achieve much better efficiency, and with fewer moving parts than compressor-refrigerators, making it the choice for space-based instruments that require cooling to the sub-Kelvin range. The low operating currents required for space-based usage, the high operating current densities to keep weight and size down, as well as the benefits of higher operating temperature provided by our "2212" superconductor are unmatched by any other superconducting wire option for powering the ADR's magnet. The innovation in this program consists of a compact, low current coil wound with a novel, very fine 2212 wire, that operates at about 6 A or lower, that generates in excess of 4 T and that operates at up to 25K (not 10K) with low hysteresis losses in ramped fields, very considerably exceeding the specifications in the guideline put forward by NASA, and exceeding even more so, present state-of-the-art ADR coil capabilities. As a first step, the prototype 2212-based fine wire will be designed and fabricated, with process development to achieve the above described properties. Based on these results, longer length prototype sections will be produced at best design and mode conditions, followed by testing to validate scalability. As a final step, a subscale test coil will be wound and tested with same bore size as the current, low temperature superconductor-based coils, in order to demonstrate the feasibility of fabricating an ADR- type of coil with this wire.

## Anticipated Benefits

Adiabatic Demagnetization Refrigerators (ADR's) for sub-Kelvin cooling of, for example , Xray calorimeters, and other similar instruments.

Magnetic shielding

Magnetostrictive cryogenic actuators and valves

Small hand held magnets to replace permanent magnets, thereby enabling field level adjustment and turning off the magnet for medical applications.

Specialty, very low loss cables produced by cabling, for ac and ramped field magnets in motors, generators.

The ADR Cycle: a Simple Schematic

**Operating**  
Magnetic Field: Low  
Heat Switch: Off  
Salt Pill: Cold

**Recycling**  
Magnetic Field: High  
Heat Switch: On  
Salt Pill: Warm

Red arrow shows direction of heat flow.

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## Table of Contents

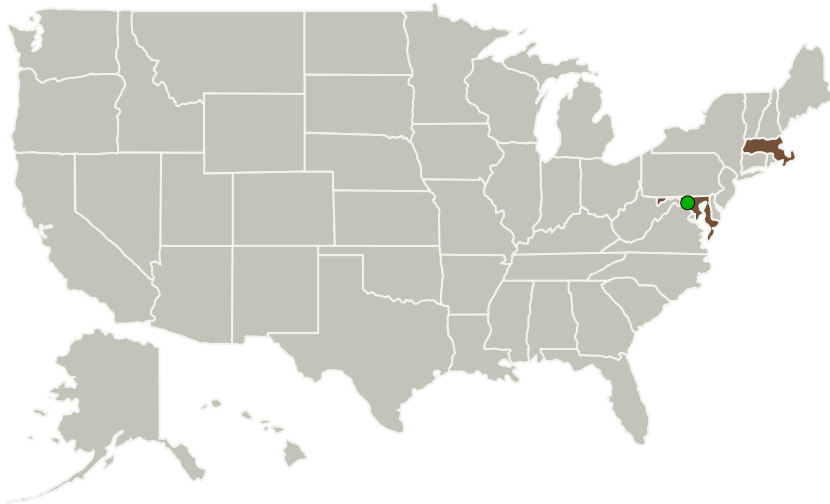
Project Introduction	1
Anticipated Benefits	1
Primary U.S. Work Locations and Key Partners	2
Project Transitions	2
Organizational Responsibility	2
Project Management	2
Technology Maturity (TRL)	2
Images	3
Technology Areas	3
Target Destinations	3


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## Primary U.S. Work Locations and Key Partners



Organizations Performing Work	Role	Type	Location
Solid Material Solutions, LLC	Lead Organization	Industry	North Chelmsford, Massachusetts
 Goddard Space Flight Center(GSFC)	Supporting Organization	NASA Center	Greenbelt, Maryland

Primary U.S. Work Locations	
Maryland	Massachusetts

## Project Transitions

 **July 2018:** Project Start

 **February 2019:** Closed out

### Closeout Documentation:

- Final Summary Chart(<https://techport.nasa.gov/file/141315>)

## Organizational Responsibility

### Responsible Mission Directorate:

Space Technology Mission Directorate (STMD)

### Lead Organization:

Solid Material Solutions, LLC

### Responsible Program:

Small Business Innovation Research/Small Business Tech Transfer

## Project Management

### Program Director:

Jason L Kessler

### Program Manager:

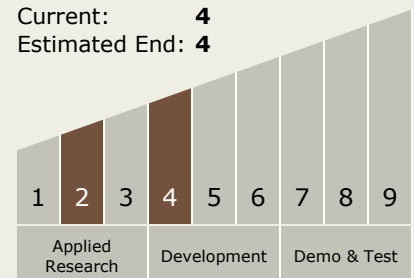
Carlos Torrez

### Principal Investigator:

Alexander Otto

## Technology Maturity (TRL)

Start: **2**  
Current: **4**  
Estimated End: **4**

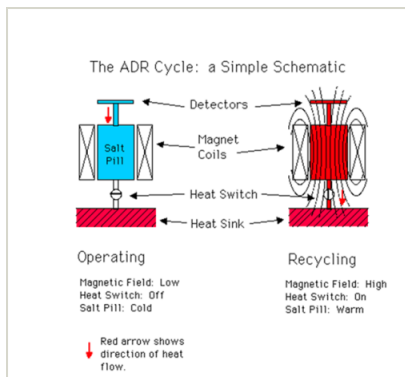


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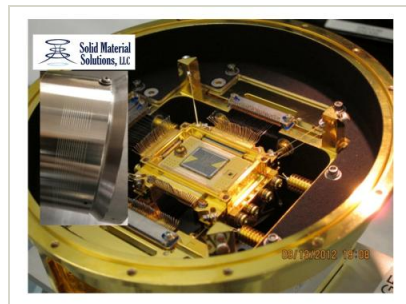


## Images



### Briefing Chart Image

Compact, Low Current Superconductor Coil Operating Above 15 K for Magnetic Cooling, Phase I  
(<https://techport.nasa.gov/image/125868>)



### Final Summary Chart Image

Compact, Low Current Superconductor Coil Operating Above 15 K for Magnetic Cooling, Phase I  
(<https://techport.nasa.gov/image/132878>)

## Technology Areas

### Primary:

- TX08 Sensors and Instruments
  - └ TX08.1 Remote Sensing Instruments/Sensors
    - └ TX08.1.6 Cryogenic / Thermal

## Target Destinations

The Moon, Mars